

CHAPTER 8

WATER AND POWER

Development problems and possibilities

WIDELY different problems and possibilities of water and power development are presented by the three principal hydrological regions into which the country is naturally divided. These regions are : (i) the humid region of East Pakistan; (ii) the area (including the Frontier Regions) drained by the river Indus and its tributaries, and most of the adjoining closed basin tracts depending on the Indus waters in West Pakistan; and (iii) the area drained by the coastal tributaries and the desert streams, comprising the Karachi area, most of the Quetta and Kalat Divisions, and the adjoining tracts.

2. *East Pakistan.*—Most of East Pakistan is a low land plain built mainly by the delta-forming activity of the Ganges, the Brahmaputra, and the Meghna, and is covered with countless swamps. It is tropical and humid, and has heavy rainfall, which is highly seasonal. Average annual rainfall is about 76 inches, with extremes of from about 53 inches in Rajshahi district to about 226 inches in Sylhet district; 85 per cent of the rainfall occurs during the five months May to September—the monsoon period. Except for the eastern districts, which are not subject to flooding, the Province comprises flood plains and delta of the three rivers. The country slopes gently towards the sea and most of the area is less than 50 feet above sea level. The land to the west of the Brahmaputra is relatively high, but in the east falls away into a depression—the *beel* and *haor* areas—in the districts of Mymensingh and Sylhet. The soil is very fertile and the land is largely cultivated. Topography and precipitation have determined the agricultural pattern. In the highlands of Tippera, Chittagong, and Chittagong Hill Tracts, not subject to flooding, jute or paddy is grown only in the rainy season. During the dry season a small area is cropped under *rabi* crops, such as pulses. Failure of the monsoon occasionally results in famine conditions over vast areas. Irrigation can insure against drought and make possible double and even triple cropping.

3. The flood plains of the rivers remain under water during the high floods, and are not available for cultivation at that time. Paddy is, however, grown when the water recedes. But if, as frequently happens, the flood is excessive or occurs at an unusual time, or does not recede sufficiently at the time of transplantation of paddy, crop failure results. Flood regulation, irrigation by gravity and surface pumping can greatly alleviate this situation. The major portion of the *haor* areas in the Sylhet and Mymensingh districts remains under water throughout the monsoon season and is dry during winter. *Boro* (winter) paddy is grown in areas that retain moisture from the monsoon flooding. Such areas, however, form a very small portion of the total. Pump-irrigation offers considerable opportunity for developing

these areas, where at present the main occupation is fishing. Large tracts of *beel* areas in Faridpur, Khulna, Tippera, Sylhet, Mymensingh, Rajshahi, Pabna, Bogra and some other districts, remain under water for most of the year. These areas can be drained and brought under cultivation. With protective embankments and irrigation, the coastal areas, which are subject to intrusion of saline sea water, can support intensified and diversified cropping, which at present is mostly paddy.

4. The total area of the Province is about 35.4 million acres of which 24.2 million acres are cultivable. Of this area 22.2 million acres are cultivated and about 21 million acres sown in an average year. Only 600,000 acres are irrigated; the remaining 97 per cent is dependent on rain. About 7 million acres are double-cropped. Adequate information is not available to determine an ultimate irrigation target, but it is estimated that in the long run the cultivated land could be increased to 26 million acres, with nearly 24 million acres sown in an average year. About 13 million acres could be irrigated by extensive drainage, construction of diversion works and canals, and pumping of surface and sub-surface water, mostly to supplement rainfall during the dry winter season. Extensive investigations are under way by the East Pakistan Water and Power Development Authority to determine the water potential of the Province. The annual flow of the rivers is estimated at 925 million acre-feet, most of which is unregulated flood water during the monsoon season. The possibilities of regulation through storage within the Province are limited to the Chittagong Hill Tracts.

5. Limited possibilities of regulation of water resources restrict the generation of hydro-electric power to about one million kilowatts. Of this power potential, 120,000 kw are being developed on the Karnafuli river; investigations are in hand to determine future possibilities. Ultimately it may be possible to develop tidal power. In the meanwhile the region will have to depend greatly on fuel-electricity, which might be generated by the natural gas at Sylhet, the peat reserves of the Province, or wood fuel from the Sunderbans or the forests of the Chittagong Hill Tracts. To electrify the rural areas, extensive transmission and distribution systems are needed to make power generally available to agriculture, industry, and other consumers.

6. The long-range development programme of this region may be summarized as follows :

- (i) Regulation of river flows to reduce flood damage, improve drainage, and to free agriculture from dependence on variable seasonal rainfall.
- (ii) Protection of the long belt of tidal lands against intrusion of sea water, and its development through improved irrigation and drainage.
- (iii) Draining of wet *haor* areas after the monsoon to enhance agricultural production, and improve health conditions.

- (iv) Determination of the ground water potential and use of ground and surface waters.

7. *The Indus Basin.*—Rainfall over most of the region comprising the Indus basin—the cradle of civilization of the Indo-Pakistan sub-continent—is unevenly distributed and inadequate to meet the full needs of the crops. The period of maximum rainfall coincides with the hottest months of the year, July to September. Temperatures and rainfall exhibit considerable fluctuations. Except for the sub-montane areas where the rainfall is adequate in some years for crop production, the Indus Basin receives less than 15 inches of rainfall a year, 30 per cent of the area receiving less than 10 inches, and 16 per cent less than 5 inches. The rivers of the Indus system are a vital source of irrigation water supply. These rivers have at the rim stations recorded maximum, minimum, and mean annual flows over a period of 25 years (1921-22 to 1945-46) of 213·6, 138·9, and 168·4 million acre-feet respectively. The corresponding volumes of the three western rivers only (the Indus, the Jhelum, and the Chenab) are 173·5, 102·8, and 135·5 million acre-feet. Inflows from the streams below the rim stations have not been regularly measured and, though not large, could be used for local development. Up to 1959, about 72 million acre-feet, excluding 20 to 40 million acre-feet of annual river losses, are estimated to have been utilized for irrigation. On the completion of schemes in progress, an additional quantity of 26 million acre-feet will be used. The total represents about 71 per cent of the average flow of the three western rivers. Additional supplies of regulated water can be made available through storage. How much additional quantity can be developed depends upon availability of suitable storage sites, which is under investigation. Basin-wide investigations have also been initiated to determine the potential and use of the ground water resources. In the Frontier Regions, no systematic investigations have so far been carried out. There is need for undertaking studies of availability, quality and quantity of ground waters and the suitability of land for agricultural production.

8. Out of a total area of 116 million acres only 40 million acres are cultivated, and about 30 million acres are sown in an average year. About 23 million acres approximately 75 per cent of the area sown in an average year are irrigated. Some 3 million acres are double-cropped. Unfortunately, waterlogging and alinity have assumed serious proportions in several parts of this region, and arable lands have been turning into marshes and salt lands. Most of the irrigated lands need drainage and supplementary water to maintain and increase agricultural production. There are sites on the main rivers and tributaries in the Indus valley where potential power heads are high, water supply is adequate, and good storage possibilities exist to generate several million kilowatts. Preliminary studies indicate that the power potential is of the order of 10 million kw, of which 6 million kw are on the Indus. Only about 200,000 kw, or 2 per cent of the total potential, have yet been developed. Detailed investigations are required to determine the desirable sites and their potential. The region has also large quantities

of coal and reserves of natural gas. The proved reserves of coal stand at 165 million tons, and those of natural gas about 8 trillion cubic feet, approximately equivalent in heating value to 300 million tons of coal. There are limited resources of oil and fuel wood. Thermal power generation will be needed to supplement seasonal power from hydro-electric stations. The possibility of using solar energy and tidal power is not ruled out. To secure best results, the hydro-electric and steam-generated power will need to be carefully integrated with existing and future power systems.

9. The long-range development situation of this region may be summarized as follows:

- (i) Useable unregulated flow supplies are already appropriated and crop yields are low, partly because of low and irrational applications of water, and partly because of salinity and waterlogging. Possible replacement even of historical uses from the eastern rivers will require construction of storage. Storage will also be needed for providing regulated supplementary supplies for the existing projects and for future development. This will also make available cheap hydro-electricity.
- (ii) Waterlogging, salinity and alkalinity exist in all irrigated areas in varying degree, and are continuing. Alkalinity and salinization of land will be aggravated with repeated use of pumped and drained water unless corrective measures are adopted. Drainage and efficient use of water and land are necessary.
- (iii) In many cases, revamping of canals to improve and rationalize water applications is needed. Remodelling will also be necessary when silt-free water is carried by them.
- (iv) Depletion of river flows will pose problems of river channel deterioration with attendant accentuation of flood damage and drainage congestion, and of sea water encroachment on the Indus delta, with serious consequences to agriculture, buildings, and health. The basin aquifers will be greatly affected by depletions. River channel rectification and flushing of the rivers will be needed.
- (v) Electrification needs to be pushed as rapidly and on as large a scale as is feasible to serve and promote industry, to pump water for the expansion of agriculture, and to meet domestic and other needs.

10. *Coastal and Desert Streams region.*—This region is coterminous with the former Baluchistan in West Pakistan, is arid, and the lands, though abundantly fertile, remain mostly uncultivated and are sparsely populated because of shortage of water. Of a total area of 82.4 million acres about 800,000 acres are sown in an average year. Approximately half of this is irrigated. The dependable flow in the streams is too small to support

expanded agriculture, and the infrequent storm flows are heavy and of short duration, making the regulation of the scanty water supply for use through storage difficult and expensive. As in the Frontier Regions, there is a shortage of hydrological data and surveys needed for systematic development. In particular, detailed information is lacking on the availability and distribution of water in the region.

11. The Quetta Division has negligible hydro-electric potential, but possesses coal which can be used to generate electricity. The Kalat Division has abundant natural gas at Sui. The remote areas of Mekran have not been surveyed. The Karachi area gets its water from subterranean storage, which has to be greatly supplemented by a long supply canal and conduit from the Indus River. Sui gas is piped to Karachi to serve industrial and domestic purposes.

Progress in the First Plan period

12. *Water.*—In 1955 the irrigated area in the country was 22·7 million acres—about 37 per cent of the total cultivated area of 61 million acres. By 1960 the irrigated area had reached 24 million acres—an increase of 1·3 million acres. Areas improved through drainage, flood regulation, and regulated supplies showed an increase of 2·57 million acres during the same period. Comparison of expectations and achievements in the First Plan is given in Table 1.

TABLE 1
Irrigation programme and results, 1955—60

Region	Programme		Results	
	New	Improved	New	Improved
East Pakistan	100	1,819	58	562
West Pakistan:				
Indus Basin and Frontier Regions	1,453	3,544	1,000	1,998
Coastal and desert streams regions	118	48	24	10
Total ..	1,671	5,411	1,082	2,570

13. Progress in reclamation of saline soils and drainage of waterlogged areas during the First Plan period was limited. Against the target of reclaiming 350,000 acres and lowering the water table in 150,000 acres, some 170,000 acres were partially reclaimed, and the water table depressed in a small area only. The First Plan provided for the construction of about 1,500 tubewells; actually 1,000 were sunk, but were not put in operation, primarily because of lack of electric power.

14. *Power.*—In 1955, installed generating capacity was 342,400 kw; of this 200,400 kw were in public utilities (four hydro-electric power plants and about 90 thermal stations) and 142,000 kw in industrial establishments. By 1960, estimated installed capacity was 906,000 kw; of this 654,000 kw were in public utilities, and 252,000 kw in industrial establishments. Table 2 shows the growth, targets and achievements in installed capacity in the three regions.

TABLE 2

Installed power capacity, estimated growth, targets and achievements, 1955—60

(Thousand kilowatts)

Region	1955 (a)		1960			
	Public utilities	Industrial establishments	Targets		Achievements (a)	
			Public utilities	Industrial establishments	Public utilities	Industrial establishments
East Pakistan ..	32.2	42.0	190.5	25.0	103.2	72.0
West Pakistan:						
Indus Basin and Frontier Regions	132.8	63.0	547.4	86.0	490.3	122.0
Coastal and desert streams region ..	35.4	37.0			60.0	58.0
Total ..	200.4	142.0	737.9	111.0	653.5	252.0

(a) Source : Chief Engineering Adviser's Office.

Installed generating capacity nearly trebled between 1955 and 1960, while *per capita* electricity consumption rose from about 10 units in 1955 to about 30 units in 1960. In East Pakistan, the increase in public supply capacity was mainly due to the steam plants at Sidhirganj (30,000 kw), Goalpara (16,600 kw), and Bheramara (8,500 kw), and diesel plants at Sidhirganj, Chittagong and Goalpara (15,900 kw). The increase in capacity owned by industry came from the Khulna newsprint factory (16,000 kw), and from such industries as sugar, jute, and textile mills (14,000 kw). In West Pakistan the increase in installed capacity in public utilities was mainly due to the commissioning of the Warsak hydro-electric scheme (160,000 kw), canal

hydels (28,000 kw), and the steam stations at Multan, Lyallpur, Montgomery, and Karachi (192,500 kw). The increase in industrial establishments was from the fertilizer factory and the Maple Leaf cement factory, Daudkhel (30,000 kw), the Zeal-Pak cement factory, Hyderabad (7,000 kw), and extensions in the sugar, textile, and other industries (43,000 kw).

15. During the First Plan period a sum of Rs. 1,770 million, against an allocation of Rs. 2,697 million, was spent on water and power development schemes in the public sector, as shown in Table 3.

TABLE 3

*Planned and actual expenditure on water and power development,
1955-56 to 1959-60*

(Million Rupees)

Region	Planned	Estimated actual
East Pakistan	928.0	350.0
West Pakistan:		
Indus Basin and Frontier Regions	1,714.0	1,415.0
Coastal and desert streams region	55.0	5.0
Total ..	2,697.0	1,770.0

Major First Plan projects

16. *East Pakistan.*—The Karnafuli hydel scheme in East Pakistan was planned to develop one of the very few water storage sites in the Province. It was designed to produce ultimately 120,000 kw of hydro-electric power, of which initially 80,000 kw would be installed ; to improve navigation to the port of Chittagong and upstream ; and to abate flood damage through regulation of flood flow in the Karnafuli river. It was scheduled for completion in 1960, at an estimated cost of Rs. 250 million. It is now expected to come into operation in 1961, and to cost Rs. 428 million—an increase of about 71 per cent over the original estimate.

17. The Ganges-Kobadak scheme envisaged pumping the Ganges waters near the Hardinge Bridge into canals for irrigating lands which could then be used for double and even triple cropping. The deteriorating Kobadak river was to be improved as a trunk drain, to be fed by a system of drainage channels, interlacing the irrigated area to regulate the water on the lands and reduce somewhat the effects of destructive floods. The canal banks were to accommodate surface transport, and the main canals and drains to provide for limited water transport. The scheme was designed to develop areas in the Kushtia, Jessore, and Khulna districts. The entire

Ganges-Kobadak scheme will irrigate about 2 million acres when completed. The Kushtia unit, which will irrigate 350,000 acres, is now well under way ; the main canals have been excavated, and a field agricultural station has been established to obtain information on soil, plant and water relationships, and to educate the farmers in irrigation techniques. The power plant at Bheramara was completed in 1958, but due to various causes the installation of large-sized pumps was held up, with the result that the progress of the scheme was slowed down. In July 1959 an auxiliary scheme for installation of medium-sized pumps was sanctioned for completion towards the end of 1960, in order to accelerate the progress of the main scheme, and to supplement the capacity of the large pumps to be installed later.

18. The Teesta sub-project, comprising a diversion dam and canals, to serve as a pilot scheme, was abandoned as inadequate after an expenditure of Rs. 3.4 million had been incurred. Investigations have been taken in hand to determine the feasibility of constructing a barrage on the Teesta river. The new project, now under preparation, is designed to irrigate nearly 1.8 million acres at a cost of Rs. 377 million, and is scheduled for completion in 1967.

19. Only 5 out of the 50 experimental tubewells proposed in the First Plan were sunk. These wells have, however, furnished information upon which to base a larger programme. Most of the drainage schemes are far behind schedule, and lack of investigations and data has made it necessary to curtail their scope.

20. *West Pakistan.*—The multipurpose Warsak project on the Kabul river was designed to develop 160,000 kw at peak load, with necessary facilities for the installation of two additional units, each of 40,000 kw, if required. The project also provides, through two high level canals and high-lift pumps, for irrigation of about 120,000 acres, lying partly in the tribal areas. It is scheduled for completion in 1960 at an estimated cost of Rs. 293 million. The irrigation works are, however, behind schedule by nearly a year.

21. The Kurram Garhi scheme, originally expected to cost Rs. 43.4 million, is now estimated to cost Rs. 68.4 million. Of the expected 4,000 kw of power only 2,200 kw is being developed, and delays in settling the water rights have postponed the irrigation benefits.

22. The Taunsa, Gudu, and Kotri barrage projects, the three major irrigation works undertaken in West Pakistan since Independence, were planned to assure adequate and timely water supplies to the vast network of inundation canals taking off from the Indus, and to bring under irrigation a total area of 6.5 million acres. The Taunsa project has made satisfactory progress. In the Kotri project the water distribution and colonization work has been rather slow, but is now being speeded up. The Gudu project construction is behind schedule.

23. The Marala-Ravi link (Chenab to Ravi), and the Balloki-Suleimanki link (Ravi to Sutlej), connecting the three rivers, are designed to make up the chronic shortages in the Sutlej Valley canals. The chain called the Bambanwala-Ravi-Bedian-Dipalpur link has been constructed to simplify delivery problems on the various channels in the Central Bari Doab system. Recurrent flood damage and inadequacy of completed works to cope with storm flows have made it necessary to undertake additions and alterations before the links can be fully utilized.

24. Progress in tubewells, drainage, and reclamation has been disappointing. Since the inception of the tubewell programme as a measure to control waterlogging, 1,351 tubewells have been sunk under the Rasul scheme. Of an allocation of Rs. 137 million, only Rs. 60.7 million was spent.

25. The Bolan Dam project contemplated the construction of an earth dam and a canal distribution system to use the flood flows of the river Bolan in the Kalat division, and to irrigate an area of 24,000 acres. The dam was completed in 1958 at a cost of Rs. 3.4 million, but the water supply is not adequate to irrigate fully the area covered by the scheme.

26. An irrigation project on the Hub river, at the site of the old Bund Murad Khan, was designed to irrigate 4,000 acres of land around Karachi by sealing the bund and pumping the stored supplies. A sum of Rs. 7.6 million was spent on the scheme without commensurate benefits, because of inadequacy of water supplies. The project has been abandoned. Detailed investigations at a cost of Rs. 2.2 million have been authorised to determine the water potential of the Hub river and the possibilities of its exploitation.

Summary of First Plan experience

27. During the First Plan period, while there has been a substantial measure of success in the implementation of multipurpose projects, several schemes have not been executed speedily; progress in flood abatement and waterlogging and salinity control has been disappointingly slow. Experience during this period underlines the prime importance of careful preparation of projects, of sound appraisal of real costs and benefits, and of careful assignment of priorities and determination of the pattern of investment. Such comprehensive preparatory work was in many cases lacking in the past, because of absence of detailed surveys, investigations, and statistical data. Impatience and enthusiasm took the place of prudence and engineering judgment, leading to waste of scarce resources—finance, strategic materials, and technical manpower. In some instances costs were grossly underestimated and returns overestimated. In a number of cases, coordination between the various phases of the same project was indifferently effected.

28. The First Plan recommended the creation in each Province of a statutory semi-autonomous body for water and power development under the general control of the Government, but enjoying in full measure the flexibility and initiative of private enterprise. A Water and Power Development

Authority was created in West Pakistan in 1958, and in East Pakistan in 1959. The establishment of these authorities, together with the simplification of sanctioning procedures, improvement of budgeting, and the creation of a Projects Division to watch progress and identify bottlenecks, should greatly help to improve performance in the Second Plan period. International assistance in the form of technical aid and training can be secured, and the Second Plan provides for increased use of the services of specialists to supply the necessary guidance and technical know-how. This should considerably help to remedy the present shortage of technical manpower. The quality and coverage of data are being improved. In future it should be possible to make better estimates of construction and development costs, and of financial returns. Past shortcomings and unfulfilled expectations do not, therefore, imply that a comprehensive programme of water and power development in the Second Plan period will not be realisable.

Second Plan programme

29. The water and power development programme in the Second Plan covers a number of large and expensive projects, as well as numerous smaller schemes. Many of them have not, however, been subjected to full technical and economic appraisal; and it may, therefore, be necessary to change the composition of the programme in the light of further, more precise information. The objectives of the development programme, which should be regarded as a unity, remain broadly the same as in the First Plan, namely:

- (i) to raise the productivity of existing agricultural lands through increased and rational applications of water, and the control of salinity and waterlogging;
- (ii) to increase farm acreage through irrigation, drainage, and flood regulation; and
- (iii) to provide electric power cheaply and abundantly in order to accelerate and strengthen agricultural and industrial development.

30. During the Plan period, a number of major schemes of irrigation and protection of extensive areas will be completed. Large tracts of land will benefit from a multiplicity of small drainage, flood regulation, tubewell, and pumping schemes. It is estimated that in the final year of the Plan period, an additional area of 2.4 million acres will be irrigated for the first time, and an area of 7.1 million acres will be improved through depression of water table, salinity control and an assured water supply. The gross installed capacity of electric power will be increased from 905,500 kw to 1,414,000 kw and the energy generated will increase from 3.20 billion units to 5.63 billion units, raising the *per capita* consumption of electricity from 30 to 50 units.

Public sector investment

31. The proposed public investment in water and power development during the Plan period is Rs. 3,140 million. Of this outlay, Rs. 92.7 million is allocated to the Central Government's programme, with the balance of Rs. 3,047.3 million divided almost equally between East and West Pakistan. West Pakistan's allocation includes Rs. 27 million for development in the Frontier Regions, and Rs. 78 million for the Coastal and Desert Streams region. The Central Government's programme includes Rs. 46.5 million for atomic energy development, Rs. 20 million for Special Regions, and the balance for the Survey of Pakistan, the Meteorological Service, and on a network analyser.

32. Table 4 shows the proposed allocations to the major sub-sectors in the two Provinces and to the Centre.

TABLE 4

*Programme of public expenditure on water and power development,
1960-61 to 1964-65*

	East Pakistan		West Pakistan		Total	
	(Million Rupees)	(Per cent)	(Million Rupees)	(Per cent)	(Million Rupees)	(Per cent)
Investigations and surveys	66.1	4.4	76.6	5.0	142.7	4.5
Multipurpose development	784.4	51.6	6.1	0.4	790.5	25.2
Irrigation	87.7	5.8	349.6	22.9	437.3	13.9
Drainage, reclamation and tubewells.	(a)	..	228.8	14.9	228.8	7.3
Flood regulation ..	245.5	16.2	64.7	4.3	310.2	9.8
Open canals .. ..	..	..	110.0	7.2	110.0	3.5
Power	288.1	18.9	662.4	43.3	950.5	30.3
Miscellaneous ..	47.3	3.1	30.0	2.0	77.3	2.5
Total ..	1,519.1	100.0	1,528.2	100.0	3,047.3	97.0
Central Government programme.	..	..	..	..	92.7	3.0
			Grand Total ..		3,140.0	100.0

(a) Included under multipurpose development, irrigation and flood regulation.

33. Of the total allocation for water and power development, Rs. 1,042 million will be spent on schemes already in progress, Rs. 325 million in East Pakistan, and the balance in West Pakistan, and Rs. 2,098 million on new schemes. Broadly speaking, allocations to the various sub-sectors in the Second Plan, as compared with provisions in the First Plan, show an increase of 32 per cent for general investigations and surveys ; 8 per cent for multi-purpose schemes ; 67 per cent for drainage, reclamation, and tubewells ; nearly 57 per cent for flood regulations ; and 47 per cent for power. There is a decrease in the allocation for irrigation, because the major schemes in the programme are nearing completion. Expenditure on open canals, which was not included in the First Plan in accordance with the definition of development expenditure applicable at that time, is covered in the Second Plan under the new definition.

Private and semi-public sector investment

34. Private and semi-public investment in water and power includes Rs. 45 million by landowners in the various irrigation project areas on water courses ; Rs. 15 million on tubewells and percolation wells, for which a subsidy is provided in the Plan ; and Rs. 190 million by the Karachi Electric Supply Corporation—a semi-public concern—on power generation and distribution.

Investigations and surveys

35. Investigations, surveys, and research are the keys to effective and coordinated planning, and they must be continued over a long period of time. Inadequacy of data in the First Plan was one of the major obstacles to preparation and proper implementation of schemes. Collection of basic data, such as temperatures, rainfall, ground water levels, and stream flows deserves high priority. Knowledge of grain size distribution, porosity, field permeability, yielding ability of the soil formations, and direction of ground water flow is necessary for sound development of the underground water potential. Soil properties must be known to solve the problems of salinity, canal seepage, waterlogging, and rationalization of water applications for optimum agricultural production. Sound drainage design and layout is not possible without adequate information on soil structure and properties.

36. Detailed soil classification and surveys are needed to determine soil fertility, crop rotations, and suitable kinds of fertilizers, and the amount and manner of their use to suit the particular soil conditions. Each type of soil has its own characteristics and properties, physical and chemical, and requires its own special treatment and use ; most soils, if well managed, can produce good yields. Soil classification and surveys have hitherto covered only a small portion of the arable lands of the country. Provision has been made for them in the agriculture programme. Detailed surveys, which may supplement the agriculture soil surveys, are envisaged also under the drainage and reclamation Schemes. All the lands must be classified and surveyed as rapidly as possible. Research is necessary in soil, water, and plant relationships ; the agriculture sector includes a suitable provision. Provision

has also been made in a number of irrigation and multipurpose projects—Ganges-Kobadak (Kushtia unit), Teesta barrage and Kotri barrage—for agricultural experiment and demonstration farms to determine these relationships and to educate the farmer in water application and crop-raising.

37. It is necessary to measure precipitation, rates of evaporation, canal losses, stream stages and flows, and the silt and mineral content of streams at key points in order to solve the complicated problems of flood control, navigation, irrigation and drainage. It is also necessary to collect data relative to the location, nature and magnitude of flood losses in order both to assess the need and to appraise the means of flood control. The number of existing rain-gauge stations in charge of the Meteorological Service will therefore be increased, and facilities will be installed for the collection of all relevant information over a larger field. A sum of Rs. 61.82 million has been provided for this purpose.

38. The Irrigation Research Institute, Lahore, needs reorganization and expansion; the provision made in the First Plan for that purpose was not utilized. A similar research institute, established in East Pakistan in 1948, also needs considerable expansion and strengthening. The facilities of the Central Hydraulics and Soil Mechanics Laboratory at Karachi have remained largely unused. A programme for expansion should be prepared. There is also need for the planned use of the existing facilities, and their enlargements as a means of determining the basic principles of river management. Great savings in costs could be effected as a result of research. A sum of Rs. 9.4 million is provided for these expansions and improvements at Dacca and Lahore.

39. For economy and coordinated planning, it is necessary to prepare detailed projects and estimates well in advance of construction. Promising specific projects must therefore be investigated and surveyed in detail so as to build up a portfolio of well-prepared schemes, and permit construction to be started on such schemes as are found feasible later in the Plan period. Detailed investigations, up to the feasibility report stage, are to be completed on the Teesta barrage project, the Tangon irrigation project and the Ganges-Kobadak project in East Pakistan. In West Pakistan, the Kunhar valley hydro-electric scheme is to be investigated in detail. Storage sites, alternative to Gomal Zam, in the Zhob-Gomal basin will be investigated for determining the feasibility of exploitation of the water resources of these streams. On the result of these investigations will depend the priorities to be assigned to any projects that may emerge. A number of other small schemes will also be investigated. A sum of Rs. 35 million has been provided for this purpose. To expedite the preparation of sound projects and a programme of resource development designed to meet the growing needs of the country, provision has been made for engaging, in addition to Pakistani specialists, the services of foreign management and consulting engineering firms with requisite experience to evaluate existing data and reports, undertake comprehensive investigations and surveys, and prepare specific projects as well as long-range integrated plans for

the development of water and power resources. Such services will also include training of Pakistani personnel, and help in evolving sound managerial and administrative procedures.

40. Altogether Rs. 142.7 million has been provided in the Plan for general investigations and surveys, an increase of almost two-and-a-half times the actual amount spent during the First Plan period.

Multipurpose development

41. For the development of multipurpose projects, the Plan provides a sum of Rs. 790.5 million, the bulk to be spent in East Pakistan. In this Province, multipurpose projects must aim at relieving drainage congestion, providing irrigation supplies, protecting land against unregulated stream and tidal flows, improving navigation, and where feasible, developing hydro-electric power. Of the total allocation made in the Plan, Rs. 224.1 million will be spent on schemes already in progress, namely the Karnafuli, Ganges-Kobadak (Kushtia unit), and Warsak projects. It is expected that by the end of the Plan period an additional 100,000 acres will be irrigated and production from 250,000 acres increased through flood protection, drainage and improved water supply. The ultimate benefits will be much larger. The completion of the Karnafuli project, with the possible addition of a third unit, will increase its electric generating capacity to 120,000 kw. The Karnafuli and Ganges-Kobadak (Kushtia unit) schemes will be completed, with an expenditure of Rs. 218.0 million, during the Plan period. Subject to proven feasibility, work will be started on the second unit of the Ganges-Kobadak project, which is estimated to cost about Rs. 490 million, and of which Rs. 120 million will be spent by 1965. The proposed Khulna multipurpose project is, in effect, the third unit of the Ganges-Kobadak Project. It provides for impoldering about one million acres of land in the southern part of the Khulna District, and for a supply of fresh water for irrigation within the polders from the Ganges through a canal taking off below the Hardinge Bridge. Definitive plans and an assessment of economic feasibility have not been completed and construction is scheduled in the later years of the Plan, subject to a favourable report. The Khulna multipurpose project is estimated to cost Rs. 329 million, of which Rs. 161 million may be spent by 1965.

42. Development of the Halda, Sangua, and Mathamuhuri basins of the Chittagong Hill Tracts, the Ganges-Brahmaputra doab, and the Brahmaputra multipurpose scheme are in the initial stages of consideration. The Brahmaputra project envisages diversion of 475 thousand cusecs of flood flow from the main Brahmaputra river into the Old Brahmaputra course. The latter will be dredged, and the flood water will be let into the Meghna through the three arms leading to Bhairab Bazar, Narsingdhi and Kalagachia. It is also proposed to revive the various dead spill channels, such as Sangshi, Banar and other Lakhya system rivers, by diverting part of the flood water into them. The project is expected to reduce the intensity of flood in the main river and irrigate 1.2 million acres during the dry

season. The hydro-electric potential of the project may be of the order of 87,000 kw. Navigation facilities will be improved by keeping open the waterways along various routes, now dead, to important centres of trade and commerce.

43. A sum of Rs. 30 million is provided for continuation of investigations and study of feasibility, and for starting construction on schemes for which economic and technical feasibility can be established.

44. The reclamation of *haor* areas is estimated to cost Rs. 150 million, of which Rs. 50 million will be spent during the Plan period. The Tipperah-Chittagong multipurpose scheme aims at serving navigation and irrigation, at an estimated cost of about Rs. 200 million. A sum of Rs. 10 million is provided for general investigations, and for starting construction late in the Plan period, if investigations establish the need and feasibility of the proposal.

45. In contrast to the humid East Pakistan, dependable flow supplies are always at a premium in the predominantly arid West Pakistan. In the Indus Basin, on completion of the Gudu Barrage, the unregulated river flows will have been fully committed, so that in the multipurpose pattern of West Pakistan, dams and storages must be built and operated for irrigation, reclamation and hydro-electric power. The development might help to mitigate flood damage until the river channels have deteriorated and need has arisen for corrective works. West Pakistan is faced with many difficulties and uncertainties. It will have to find alternative sources of supply for its irrigation now dependent on the eastern rivers—the Sutlej, the Beas, and the Ravi. Irrigation and reclamation requirements indicate the urgent need for new storage. Feasible sites are available, but the immediate resources do not permit exploitation of storage capacity beyond what is contemplated in the Indus Basin replacement works. A number of possibilities of multipurpose development exist in some of the less-developed parts of West Pakistan. Provision was made in the First Plan for investigations, surveys, and the preparation of detailed projects, but no projects have yet been formulated. Provision is made for such studies in the Second Plan. Provision has been made for the completion of the Warsak project.

Irrigation

46. The total amount allocated to single-purpose irrigation works in the Plan is Rs. 437 million, of which Rs. 274 million will be spent on schemes already in progress—the Kotri, Gudu, Taunsa, Thal and Warsak canals. The total amount to be invested on irrigation is larger, because it includes substantial investment on multipurpose, drainage, reclamation and tubewell schemes, and because of the inclusion of Rs. 110 million for open canals as a part of this programme. The implementation of the Rs. 437 million programme will make available by 1965 an additional irrigated area of 1.88 million acres of which 1.14 million acres will be covered by schemes already under way, and 740,000 acres by new schemes. This should make further increases possible later.

47. In East Pakistan, the Tangon project, on which investigations were started in the First Plan period, is scheduled for completion by 1965. It is designed to utilize the low heads of the Tangon and Koratoya rivers by means of three barrages and canals, ultimately irrigating about 154,000 acres in the Dinajpur district. A scheme comprising 300 tubewells and 80 small low-lift pumps for pumping surface water from local streams, all to be energized from a central diesel power station, is proposed for such high areas in the districts of Dinajpur, Rangpur, Pabna and Rajshahi as cannot be irrigated from the Tangon or Teesta scheme. The scheme, which is estimated to cost Rs. 36.2 million, will irrigate an area of about 100,000 acres, and will be completed by 1965. Provision has also been made for about 16 small irrigation schemes throughout the Province. A large number of low-lift pumps to be operated by private persons will also be commissioned.

48. The irrigation programme in the Indus Basin comprises mostly schemes already in progress. On the Thal project the work on colonization is behind schedule but is expected to be completed by 1965. In the Kotri project, work on colonization and the construction and remodelling of the canal network is under way, and is scheduled for completion by 1963. The Taunsa project was formally opened in March 1959, and the work on the distribution system will be completed during the Plan period. The Gudu project was to be completed in 1958, but has been delayed for various reasons. The headworks are now expected to be completed by 1962. Work on the canals and distributaries is already in hand. The Warsak canal system is now scheduled for completion in 1961. On completion of Warsak canals which will utilize the regulated waters of the Kabul river, the Bara Nala water supplies will become surplus. The Bara canal scheme will use this surplus for the perennial irrigation of about 20,000 acres, and intermittent irrigation of an additional 40,000 acres. In addition to the flow irrigation projects, pump irrigation from streams and canals holds promise of opening up new areas. The Plan makes provision for a pilot pumping scheme on the Nara canal of the Sukkur barrage to irrigate 5,000 acres. Provision has been made for small irrigation schemes throughout the Province. These will comprise diversion bunds, electric and diesel pumping sets and tubewells. Provision has also been made for subsidizing, through the Department of Agriculture, some 700 tubewells and 2,000 percolation wells to help promote intensive regional development where water conservation needs are more pressing. The Isplingi valley in Kalat division, having additional untapped ground water resources, offers opportunities for intensive development of crops and livestock through irrigation. Special attention will also be given to the development of the Porali Basin.

49. The Frontier Regions, apart from benefiting from other irrigation and tubewell schemes undertaken in the Province, are allocated an additional Rs. 10 million to be spent on irrigation works suitable for their special conditions and requirements.

50. The Coastal and Desert Streams region suffers from lack of adequate information on local hydrology. Planned development in the area must

therefore await detailed investigations and collection of requisite data, for which a provision is made in the Plan. In addition, a provision of Rs. 14 million has been made for minor schemes, including tubewells, on the assumption that feasible schemes will be formulated.

Drainage, reclamation, and tubewells

51. Considerable increments in agricultural production can be achieved through drainage, reclamation, and tubewells. This programme is concerned with West Pakistan only ; East Pakistan's needs are covered by multipurpose development, irrigation, and flood regulation. In the Indus basin especially, lands have gradually deteriorated, and production has decreased, because of maladjustment of land and water resources, lack of adequate drainage, inadequate and unsound water applications, continuous mining of natural fertility, defective agricultural practices, and simi-l factors. Above all, the deterioration is attributable to the lack of adequate drainage, the consequent rise of the water table and the salinization of land. Salinity and waterlogging pose a serious threat to the national economy. It is estimated that over 50 per cent of the irrigated land is affected, an area of some 12 million acres. Control of salinity and waterlogging presents a gigantic problem ; the cost of drainage, creation of additional water supplies through storage, and revamping of the canal systems needed to deal with the problem effectively has been calculated to be as high as Rs. 25,000 million. Expenditures on this scale are clearly well beyond the resources of the country. In the circumstances, measures to control and depress the water table, and to reclaim the land, will have to be spread over several Plan periods. This is an unfortunate position, since the great urgency of counteracting the menace of salinity and waterlogging is incontestable.

52. Progress in implementation of the drainage programme in the First Plan period was slow. Detailed investigations and surveys have now, however, been undertaken over almost the whole of the basin. The Plan provides Rs. 103.2 million for drainage to be developed in practically every irrigation scheme area. About 1,000 miles of open drains are to be constructed —insufficient to meet total requirements, but large in comparison with achievements in the First Plan. The programme is given a high priority, and additional funds will be allocated if this is warranted by the rate of progress. Drainage of irrigated lands will need much sustained effort. Public cooperation and participation are indispensable in such ventures. Neither the resources of the Government nor those of the land-users are, by themselves, adequate to implement an effective drainage programme, but their combined efforts can succeed. The main and secondary drains should be provided by the Government ; the field drains, on the analogy of water courses, should be constructed, operated and maintained by the farmers and land-owners themselves. The Government will provide the requisite technical guidance. In the drainage of irrigated lands, group action is essential ; this can be mobilized through the Village AID Organization, or by creating semi-public organizations under Provincial laws.

53. Strategically located tubewells have been advocated as the principal method for solving the drainage and salinity problem. The argument is that through pumping, the water table can be depressed and controlled, and water so obtained can be utilized for leaching the salts below the crop root level and for irrigation. Eight reclamation schemes covering an area of 480,000 acres initiated in the First Plan were later incorporated into a single comprehensive salinity control and reclamation project. The scheme envisages drilling of 2,200 tubewells designed to serve an area of 1.6 million acres in the Rechna and Chaj doabs, to be completed in 1961 at an estimated cost of Rs. 68 million, excluding the cost of an electric distribution system. The Plan provides for completing the project, with an additional Rs. 30 million to be lent to the Soil Reclamation Board for providing physical facilities for the application of new and existing water and reclamation techniques efficiently. Tubewells, however may not provide the complete solution, unless the conditions are ideal, which is rare. The solution of such problems seems to lie in providing both surface and sub-surface drainage, the latter combining in varying degree open drains, closed drains, and pumped well. It is, therefore, necessary that the effectiveness of the programme under execution should be studied by a body of experts, before launching another substantial tubewell programme. Provisionally an additional sum of Rs. 40 million has been provided for similar tubewells in other suitable areas.

Flood regulation

54. Floods have occurred frequently, and with great severity, causing enormous losses and misery. It has been estimated that in East Pakistan alone in the three successive years 1954 to 1956, the rice area partially or totally damaged was of the order of 8.3 million acres. The corresponding loss in agricultural production has been put at 1.717 million tons, valued at Rs. 468 million. Enormous losses have occurred also in West Pakistan from time to time. Here the high embankments of the new link canals, cutting across the natural drainage, have aggravated an already bad situation.

55. A Flood Commission for East Pakistan was established in December 1955, and a Flood Control Board in June 1956. A United Nations Water Control Mission studied the flood control and water resources development problems of East Pakistan in 1956-57. In 1957 the Government of West Pakistan created the West Pakistan Flood Commission to prepare an integrated basin-wide flood control plan. For want of adequate basic data, however, no comprehensive flood control measures have so far been formulated in either Province.

56. The Plan provides a sum of Rs. 310.2 million for flood regulation, of which Rs. 56.37 million will be spent on schemes now under way. Almost four-fifths of this allocation will be spent in East Pakistan, where an area of 800,000 acres is likely to be improved. The work consists primarily of opening up congested channels, thereby decreasing the time of inundation of land, and providing for earlier agricultural activities. The programme includes

protective embankments and channel realignment to reduce damage to health and property from ponded water. East Pakistan's allocation of Rs. 245.5 million includes Rs. 35.27 million for schemes in progress. Five of a total of six large schemes will be completed during the Plan period : the Faridpur drainage scheme ; the Feni sub-division flood reduction scheme; re-excavation of Ghungur, Salda and Buri Nadi in Tippera district ; strengthening of embankments of the Gumti river ; and dredging of the Gumti. East Pakistan will also complete a number of small schemes. It will further undertake new schemes, including the raising, strengthening, and construction of tidal embankments, draining of the Sadar sub-division of Noakhali district, flood regulation in the area between Surma and Kushiya, improvement of the Manu river, resuscitation of the Ichamati river in the Pabna district, and a number of other schemes.

57. West Pakistan will complete the four schemes under execution—the Kot Hafiz Scheme, Bara and Chilla Nallah, rehabilitation of river bunds, and provision of mobile wireless sets to complete a flood warning system on the major rivers. The cost of this programme is Rs. 21.10 million. Another Rs. 43.60 million will be spent on new schemes, including a twenty-mile river bund near Kashmore, remodelling of Balloki barrage, detention dams in Dera Ghazi Khan, and provision for such further measures of flood control as may be recommended by the West Pakistan Flood Commission. In the Coastal and Desert Streams region, the streams are subject to flash floods, with peaks which are sharp but of low total volume. Such floods wash away the *bunds* constructed by cultivators to divert the flow to cultivable lands. Steps will be taken to build permanent structures both to control floods and to provide irrigation.

Open canals

58. West Pakistan has a network of canals, a large number of diversion works, and a growing mileage of embankments and drains. Considerable sums are expended annually on their extension, improvement, and replacement. This expenditure was not included in the First Plan. A sum of Rs. 110 million is provided in the Second Plan.

Power

59. The objectives of the power programme in the Plan are :

- (i) to install additional generating capacity to meet increased power demand during the Plan period ;
- (ii) to provide transmission and distribution facilities to meet the growing and diverse demands over large areas ; and
- (iii) to make a modest beginning with electrification of rural areas.

The Plan provides Rs. 950.5 million for power schemes in the public sector, Rs. 288.1 million to be spent in East Pakistan and the balance in West Pakistan. Of the total, Rs. 320 million will be spent on schemes already in progress. The Karachi Electric Supply Corporation is expected to invest Rs. 190 million during the Plan period.

60. *Generation.*—Compared with Rs. 392.7 million allocated for generation of power (excluding the share of the cost of public sector multipurpose projects chargeable to power) in the First Plan, Rs. 445.4 million is provided in the Second Plan : Rs. 275.4 million in the public sector, and Rs. 170 million in the semi-public sector. During the Plan period, the installed capacity will be increased by about 508,000 kw, an increase of 55 per cent over the capacity available in 1960. The new thermal stations included in the Plan are all based on indigenous fuels. By 1965 the total installed capacity will be about 1,414,000 kw, of which 1,126,000 kw, will be in public utilities and 288,000 kw in industrial establishments. Some of this capacity is likely to be retired due to obsolescence and uneconomic operation, depending upon the results of a factual survey of the condition of units and the growth of demand. On the assumption that some 142,000 kw (some 34,000 kw in East Pakistan, and 108,000 kw in West Pakistan) might be retired, the net installed capacity at the end of the Plan period will be 1,272,000 kw, of which 1,090,000 kw will be in public utilities and 182,000 kw in industrial establishments. Table 5 shows the comparative position at the end of the First and the Second Plan periods.

TABLE 5

Generating capacity at the end of the Second Plan period after possible retirements as compared with that available at the end of the First Plan period.

(Thousand kilowatts)

	1960			1965		
	Public utilities	Industrial establishments	Total	Public utilities	Industrial establishments	Total
East Pakistan	103.2	72.0	175.2	216.0	81.5	297.5
West Pakistan:						
Indus Basin and Frontier Regions.	490.3	122.0	612.3	670.3	52.0	722.3
Coastal and desert streams region.	60.0	58.0	118.0	204.0	48.0	252.0
Total ..	653.5	252.0	905.5	1,090.3	181.5	1,271.8

61. Public utilities will account for 86 per cent of total capacity in 1965, as against 59 per cent in 1955, and 72 per cent in 1960. Public utilities using indigenous resources of fuel and water power will greatly expand in later years, and gradually displace industrial power, which is mostly based on imported diesel oil and coal. Because the load estimates vary there is no certainty that the available power will be fully used readily, although there is reason to believe that demand is rising sharply. The Government have initiated load surveys in the two Provinces on the basis of field data. The completion of these surveys should be expedited, and arrangements made to conduct power load surveys at regular intervals.

62. The energy generated is expected to increase from about 3.20 billion units in 1960 to about 5.63 billion units in 1965. The corresponding *per capita* consumption of electricity is expected to rise from 30 to 50 units. Low cost power supply is an important means of accelerating economic growth and improving social conditions. For this reason, improvement in the load factor and the formulation of sound electric tariff rates assume great importance.

TABLE 6

Increase of net installed power capacity by mode of generation, 1955—65

(Thousand kilowatts)

	Installed capacity in 1955	Installed capacity in 1960	Net installed capacity in 1965	Percentage increase or decrease during the Plan period
Public utilities :				
Hydro	62.7	250.7	382.7	52.7
Steam	67.7	312.8	612.3	95.7
Diesel	70.0	90.0	95.3*	5.9
Sub-total ..	200.4	653.5	1090.3	70.0
Industrial establishments ..	142.0	252.0	181.5	—28.0
Grand total	342.4	905.5	1271.8	40.3

*Includes 15,000 kw in dual-fuel plant to be installed at Karachi, which will start on diesel oil but operate on natural gas.

63. The hydro-electric and steam plant capacities in the public utilities will increase by 53 and 96 per cent respectively during the Plan period ; the diesel plant capacity will increase by 6 per cent only. The capacity in industrial establishments, which is all thermal (mostly diesel), will, on the other hand, decrease by 28 per cent, as a result of the expected cheaper power from the public supply (Table 6). Installed capacity in East Pakistan will increase by 156,000 kw, of which 120,000 kw will come from the Karnafuli, hydro-electric station, and 36,000 kw from the Fenchuganj fertilizer plant. A sum of Rs. 15.3 million has been provided for the acquisition and modernization of a number of private electric supply undertakings. In the Indus Basin, an additional capacity of 202,000 kw will be installed in public utilities. Of this 57,000 kw will be contributed by Gujranwala hydel (12,000 kw), Sukkur thermal (30,000 kw) and Hyderabad thermal (15,000 kw) stations which were sanctioned in the First Plan period. Further additions during

the Second Plan period will accrue from possible extensions at Multan (130,000 kw), and Hyderabad (15,000 kw). An additional capacity of 150,000 kw is proposed in the public utilities of the Coastal and Desert Streams region during the Plan period. Of this 75,000 kw are from the extension of the Karachi 'B' steam station (60,000 kw) and from the installation of the 15,000 kw dual-fuel plant already under way. The balance will be from the proposed new steam stations at Karachi (60,000 kw), and Quetta (15,000 kw).

64. *Transmission and distribution.*—The Plan accords a higher priority to transmission and distribution of existing power than to generation of additional power, and provides a sum of Rs. 695 million for this purpose, as compared with Rs. 255 million provided in the First Plan. A number of regional grid systems with necessary distribution facilities is provided to serve all major load centres. The total length of transmission and distribution lines (11 kv and above) will increase from about 5,000 miles in 1960 to about 15,000 miles in 1965. The mileage by regions is shown in Table 7.

TABLE 7

*Length of transmission and distribution lines in circuit miles
(11 kv and above)*

	Mileage in 1955	Estimated mileage in 1960	Estimated mileage in 1965
East Pakistan	45	600	1,500
West Pakistan :			
Indus Basin and Frontier Regions ..	1,300	4,300	13,200
Coastal and desert streams region ..	50	100	300
Total ..	1,395	5,000	15,000

65. In East Pakistan, the high-voltage transmission line connecting Dacca, Chittagong, and Karanafuli will be completed early in the Plan period, and will be extended further to Sylhet. A separate high-voltage grid will be established, with the interconnection of Goalpara and Bheramara thermal stations. These grids, along with extensive secondary transmission and distribution systems, will serve the major load centres throughout the Province. To accelerate the use of available power in East Pakistan by prospective industrial users, who experience considerable difficulties in the selection and purchase of electrical equipment necessary for the installation of power supply connections, the East Pakistan Water and Power Development Authority propose to maintain ready stocks of equipment for supply to consumers. For this purpose a sum of Rs. 25 million has been provided as a revolving fund.

66. The programme for the Indus Basin envisages completion in 1961 of the West Pakistan high-tension grid designed to interconnect Multan and Warsak power stations with the existing grid, which links up the power stations at Malakand, Dargai, Rasul, Daudkhel, Shahdara, Chichokimallian, Lyallpur, and Montgomery. The primary grid will deliver power at ten primary load centres at Multan, Lyallpur, Sargodha, Daudkhel, Peshawar, Wah, Kharian, Montgomery, Rawalpindi and Lahore. A secondary transmission and distribution system will then take the power from these centres and deliver it to 25 new distribution centres by 4,000 miles of transmission and distribution lines, at pressures varying from 400 to 132,000 volts. The cost of the system is estimated at Rs. 206.9 million. The system will also serve for possible future electrification of the main North Western Railway line. Funds have been provided for the distribution of electricity to ultimate consumers over a wide area. Separate grids with adequate distribution facilities have also been provided around Sukkur and Hyderabad to supply power to all adjoining towns and some villages from the proposed central thermal stations. Consideration of the interlinking of these grids with each other and with the northern grid, and ultimately with Karachi, has been deferred until more hydro-electric power becomes available and network analyser studies are made. During the Plan period, a new thermal grid will be constructed around Quetta to serve the local coal mines and other towns from a central coal-fired steam station. The existing distribution system in Karachi will be suitably strengthened and expanded.

67. *Electrification of towns and villages.*—Power facilities so far have been limited to the bigger and a few medium-sized towns, covering only about 10 per cent of the total population. All towns with a population of 25,000 and more (according to the 1951 census) and numbering 56 are electrified ; of the 186 smaller towns with a population range of 5,000 to 25,000, only 64 are electrified. Of 100,000 villages, with population less than 5,000, only 370 are electrified. The cost of electrification is heavy in rural areas because of lack of load density. Even in closely populated areas where it is possible to serve a large number of villages from a central station, the cost of electrification will be high. This is a task, therefore, which will take many years to accomplish. The proposed transmission and distribution systems to interlink power supplies and serve major load centres and tubewells makes it practicable to extend electric power benefits to villages situated along and near these lines, and in the proximity of bigger towns. It is calculated that with an outlay of Rs. 250 million, an additional 50 towns and about 2,000 villages can be electrified. A provision has been made in the Plan accordingly.

Machinery pools

68. Because of the greatly increased tempo of construction activity, and the huge size of many water and power schemes, machinery has come to be used on an extensive scale. In the interest of effective maintenance, reduction in stocks of spare parts, training of operators and mechanics, and improved

efficiency in construction, it is necessary to standardize equipment, and provide workshop facilities on an adequate scale. To ensure effective and economic use of equipment, an inventory of all that is available must be maintained, and suitable log and record books to watch the working of each piece and efficient accounting to maximize the returns, should be introduced. An amount of Rs. 60 million, in the nature of a revolving fund, has been provided for this purpose, Rs. 30 million in each Province.

Dredger fleet

69. East Pakistan has a dredger fleet comprising one old and 20 new dredgers. A central floating workshop to carry out repairs and maintenance is functioning, and a small slipway is under construction. To operate the fleet at maximum effectiveness and economy, there is need for a shore workshop, modifications in the existing fleet, and provision of additional equipment and accessories. Foreign specialists need to be recruited to operate the fleet and to train technicians in the country. A sum of Rs. 9.8 million has been provided to meet these needs.

Atomic energy

70. Atomic energy development is allocated Rs. 46.5 million. This should make possible :

- (i) continuance of the programme of training of nuclear scientists and engineers ;
- (ii) intensive training over extended periods of selected scientists and engineers of outstanding ability and merit ;
- (iii) exploration for radio-active minerals in Pakistan ;
- (iv) establishment of an Institute of Nuclear Research and Reactor Technology with a swimming pool research reactor (1 MW—5MW) at the headquarters of the Atomic Energy Commission ;
- (v) establishment of a nuclear accelerator of 10—15 Mev in East Pakistan ; and
- (vi) establishment of a suitable number of medical and agricultural centres in the country using isotope techniques.

71. The reactor will be used for training scientists and engineers, and to produce isotopes for biological, medical, and industrial research. The research effort will be directed towards theoretical and experimental studies of reactor design, component and metallurgical testing, intensive studies in nuclear chemistry, and investigations in fundamental nuclear physics. The isotopes produced by the reactor and the accelerator will be used for radio isotope therapy, for sterilization of crops, and for breeding hardier mutations of crops. In order to secure the maximum advantage from the

programme, a suitable number of medical and agricultural centres will be set up in both East and West Pakistan in consultation with the Health and Agriculture Departments.

Meteorological Service

72. The Meteorological Service observes, collects, and disseminates information on rainfall, floods, temperatures, winds, hailstorms, snow, ice and humidity. The value of the information depends on its representative character, which is conditioned by the extent of coverage of the observations. At present there are about 122 surface meteorological stations, 22 pilot balloon stations, and 3 regional meteorological observatories. To improve the coverage the number of meteorological observatories and pilot balloon stations will be increased during the Plan period. A provision is made for the installation of hydrogen plants in both the Provinces. Arrangements for radiosonde and rawinsonde observations exist at some stations; the Plan provides for the installation of similar instruments at all international airports in the country. The equipment at all aerodrome observatories will be modernized, in accordance with the standards laid down by the International Civil Aviation Organization and the World Meteorological Organization, to facilitate jet aircraft operation. An accurate time single service, to serve also other countries of South East Asia and the Middle East, will be provided. The geophysical organization for survey and study of seismic, geomagnetic ionospheric, and atmospheric physics parameters established at Quetta will be further expanded and strengthened. Laboratory and workshop facilities of the Service will be improved and expanded, and new equipment will be installed for the design, testing, maintenance, and repair of the various types of instruments required. A meteorological workshop and laboratory will be established in East Pakistan. The number of hydro-meteorological observatories and rainfall stations will be nearly doubled during the Plan period. Such observatories will be set up in both the Provinces, and will cover areas for which at present inadequate data are collected.

Survey of Pakistan

73. The Survey of Pakistan, which is responsible for the survey of the country and the preparation and maintenance of topographical, geographical, and special-purpose maps, needs expansion to meet the growing civil and defence needs. The Plan makes provision for the Survey to procure the needed equipment, instruments, and facilities. A mathematical instrument office will be set up to make and repair the delicate instruments used in the work of the Survey; in time this office should be able to supply most of the demands of mathematical instruments of Government departments, universities, colleges, and other organizations. The existing facilities at the photogrammetric and geodetic offices of the Survey will be modernized and expanded. An air photographic agency will be set up, since aerial photography can make an important contribution to the topographical mapping of the country, which is particularly essential for the development of water and power schemes.

Requirements of personnel and key construction materials

74. Lack of adequately trained personnel in sufficient numbers has been one of the major obstacles in the way of the implementation of the development programme. There has been a shortage of engineers required to carry out even the normal departmental duties. There is a clear need for assessing the firm requirements of technical personnel for the execution of programmes.

75. Approximate estimates of quantities of key construction materials required during the Plan are: steel, 190,000 tons; cement, 1.9 million tons; and coal, 200,000 tons. More careful preparation is required than has been the case in several instances in the past of schedules of requirements of materials at the time of formulation of projects. Also more timely procurement action is needed to ensure delivery of the material to meet construction schedules.